CLAIMS

What is claimed is:

[Note: Bold bracketed ***and size-reduced* cross-referencing text** (e.g., **[100]**) is provided in the below claims as an aid for readability and for finding corresponding (but not limiting) examples of support in the specification. The bracketed text is not intended to add any limitation whatsoever to the claims and should be deleted in all legal interpretations of the claims and should also be deleted from the final published version of the claims.]

1. A method **[300]** for reducing micromasking residue **[254,355]** remaining within an exposed interface region **[160/252]** of an oxide-based hardmask layer **[160]** and a metal-containing anti-reflection coating layer (ARC layer) **[152]** after the hardmask layer **[260a-c]** has been patterned, where the residue includes nodules each having a base anchor portion **[255b,355b]** and an upper body portion **[255a,255d]**, the method comprising:

(a) providing a chemically reactive, first agent **[335]** which will react with a first metal element **[Ti]** of the metal-containing ARC layer to produce a volatile byproduct **[357]**, the first agent being sufficiently small in size to operatively enter reaction zones of the base anchor portions of the residue nodules so as to react with the first metal element **[Ti]**, if any, in the respective base anchor portions; and

(b) subjecting the residue nodules to a plasma **[354]** including said chemically reactive, first agent.

2. The residu reducing method [300] of Claim 1 wherein

(a.1) said chemically reactive, first agent [335] is selected from the group consisting of: chlorine and HCl.

3. The residue reducing method [300] of Claim 1 wherein

(a.1) said chemically reactive, first agent [335] is selected from the group consisting of: Cl_2, HCl and BCl_3 .

4. The residue reducing method [300] of Claim 1 wherein

(a.1) said first metal element is titanium.

5. The residue reducing method [300] of Claim 1 wherein

(a.1) said oxide-based hardmask layer [160] includes Plasma-Enhanced Tetra-Ethyl-OrthoSilicate (PE-TEOS).

6. The residue reducing method [300] of Claim 5 wherein

(a.2) said interface region [160/252] is defined by the PE-TEOS material contacting the metal-containing ARC layer.

7. The residue reducing method [300] of Claim 1 wherein

(b.1) in addition to said chemically reactive, first agent [335] said subjecting step subjects the residue nodules and/or fibers to a plasma [354] further including one or more additional chemically reactive agents which can react with, and volatize materials present in the base anchor portions of the residue nodules and/or fibers.

8. The residue reducing method [300] of Claim 1 and further comprising:

(c) providing a relatively, chemically nonreactive, second agent [354,320] which does not substantially react with the first metal element [Ti] of the metal-containing ARC layer to produce a volatile byproduct [357], the second agent being sufficiently large in average mass for physical bombardment purposes to operatively weaken attachments of the base anchor portions of the residue nodules to the interface region [160/252] so as to thereby encourage break away and removal of the residue nodules from the interface region; and

(b.1) wherein in addition to said chemically reactive, first agent [335] said subjecting step subjects the residue nodules and/or fibers to a plasma [354] including said second agent.

9. The residue reducing method [300] of Claim 8 wherein

(a.1) said second agent [354,325] is selected from the group consisting

of: argon, helium, n on, krypton and nitrogen.

10. The residue reducing method [300] of Claim 8 wherein

(b.2) said subjecting step includes establishing a first inflow rate for the first agent in the range of about 10 sccm to about 50 sccm.

11. The residue reducing method [300] of Claim 10 wherein

(b.3) said subjecting step includes establishing a second inflow rate for the second agent in the range of about 50 sccm to about 150 sccm.

12. The residue reducing method [300] of Claim 11 wherein

(b.2a) said subjecting step includes establishing the first inflow rate for the first agent in the range of about 15 sccm to about 25 sccm; and

(b.3a) said subjecting step includes establishing the second inflow rate for the second agent in the range of about 70 sccm to about 90 sccm.

13. The residue reducing method [300] of Claim 11 wherein

(b.2b) said first agent is chlorine; and

(b.3b) said second agent is argon.

14. The residue reducing method [300] of Claim 8 wherein

(b.2) said subjecting step includes establishing a plasma pressure range of about 2mT to about 15mT.

15. The residue reducing method [300] of Claim 14 wherein

(b.2) said subjecting step includes establishing a plasma pressure range of about 6mT to about 12mT.

16. The residue reducing method [300] of Claim 8 wherein

(b.2) said subjecting step includes establishing a plasma power in the range of about 300 watts to about 600 watts.

17. The residue reducing method [300] of Claim 16 wherein

(b.2a) said subjecting step includes establishing for a chamber supporting said plasma, a pedestal bias power in the range of about 80 watts to about 200 watts.

18. The residue reducing method [300] of Claim 8 wherein

(b.2) said subjecting step includes maintaining said plasma having said first and second agents for an effective residue reducing time of about 3 seconds to about 20 seconds.

19. A computer-implementable recipe [380] defined by one or both of computer-readable media and manufactured, computer instructing signals for use in a plasma chamber [310] for reducing micromasking residue [254,355]

remaining within an interface region [160/252] of an oxide-based hardmask layer [160] and a metal-containing anti-reflection coating layer (ARC layer) [152] after the hardmask layer [260a-c] has been patterned, where the residue includes nodules and/or fibers each having a base anchor portion [255b,355b] and an upper body portion [255a,255d], the computer-implementable recipe being structured to cause the plasma chamber to carry out a residue reducing method comprising:

(a) providing into the chamber a chemically reactive, first agent [335] which will react with a first metal element [Ti] of the metal-containing ARC layer to produce a volatile byproduct [357], the first agent being sufficiently small in size to operatively enter reaction zones of the base anchor portions of the residue nodules and/or fibers so as to react with the first metal element [Ti], if any, in the respective base anchor portions of the residue nodules and/or fibers; and

(b) subjecting the residue nodules and/or fibers to an in-chamber plasma [354] including said chemically reactive, first agent.

20. The computer-implementable recipe [380] of Claim 19 and further wherein said recipe-driven method of reducing residue is caused by the recipe to include:

(c) providing into the chamber a relatively, chemically nonreactive, second agent [354,320] which does not substantially react with the first metal

element [Ti] of the metal-containing ARC layer to produce a volatile byproduct [357], the second agent being sufficiently large in mass for physical bombardment purposes to operatively weaken attachments of the base stems of the residue nodules and/or fibers to the interface region [160/252] so as to thereby encourage break away and removal of the residue nodules and/or fibers from the interface region; and

(b.1) wherein in addition to said chemically reactive, first agent [335] said subjecting step subjects the residue nodules and/or fibers to an in-chamber plasma [354] including said second agent.

21. A patterned monolithic integrated circuit [350,110'] having a patterned metal layer [140'] whose pattern has been transferred through an interface region [160/252] of an oxide-based hardmask layer [160] and a metal-containing anti-reflection coating layer (ARC layer) [152] where after the hardmask layer [260a-c] has been patterned, the interface region contains micromasking residue [254,355] and the residue includes nodules and/or fibers each having a base anchor portion [255b,355b] and an upper body portion [255a,255d], said monolithic integrated circuit being the product of a micromasking residue reducing method comprising:

(a) providing into a plasma chamber, a chemically reactive, first agent [335] which will react with a first metal element [Ti] of the metal-containing

ARC layer to produc a volatile byproduct [357], th first agent being sufficiently small in size to operatively enter reaction zones of the base anchor portions of the residue nodules and/or fibers so as to react with the first metal element [Ti], if any, in the respective base anchor portions of the residue nodules and/or fibers;

(b) providing into the plasma chamber, a relatively, chemically nonreactive, second agent [354,320] which does not substantially react with the first metal element [Ti] of the metal-containing ARC layer to produce a volatile byproduct [357], the second agent being sufficiently large in mass for physical bombardment purposes to operatively weaken attachments of the base anchor portions of the residue nodules to the interface region [160/252] so as to thereby encourage break away and removal of the residue nodules from the interface region; and

(c) subjecting the residue nodules and/or fibers to an in-chamber plasma [354] including said first and second agents.

22. A patterned monolithic integrated circuit [200'] comprising:

(a) a patterned metal layer [240'] including a metal-containing anti-reflection coating layer (ARC layer) [252'] ;

(b) a patterned and oxide-based hardmask layer [260'] disposed on the ARC layer, where the pattern of the hardmask layer has be n used to pattern the underlying metal layer,

(b.1) wh re an interface region [260a'/252a'] of the oxide-based hardmask layer and the metal-containing ARC layer contains buried nodules [254a'] which would have constituted micromasking residue [254,355] if the buried nodules had been exposed at the time the hardmask pattern was transferred to the metal layer.

23. The integrated circuit [200'] of Claim 22 wherein the buried nodules include those having a base anchor portion [255b,355b] rich in metal content from the metal-containing ARC layer, and an upper body portion [255a,255d] that is resistant to removal by merely an oxide-etching process [201] or merely a metal etching process [202] .

24. A method [400] for preventing or reducing formation of micromasking residue between a metal-containing anti-reflection coating layer (ARC layer) [152] and an oxygen-containing hardmask layer [260a-c] where said residue can be microscopically observed after the hardmask layer has been patterned, said method of preventing or reducing comprising:

(a) interposing an oxygen-poor interfacial layer [453] between the metal-containing ARC layer and the oxygen-containing hardmask layer.

25. The residue reducing method of Claim 24 wherein:

(a.1) said ARC layer contains substantial amounts of titanium;

(a.2) said hardmask layer contains PE-TEOS; and

(a.3) said oxygen-poor interfacial layer [453] is composed of $Si_xO_yN_z$, where x>0, z≥0 and where the density of oxygen in said oxygen-poor interfacial layer is less than the density of oxygen within the PE-TEOS of the adjacent layer hardmask layer.

26. The residue reducing method of Claim 24 wherein:

(a.1a) the ratio of y to x is substantially less than 2 to1.

27. The residue reducing method [300] of Claim 8 wherein a volumetric inflow ratio is established for respective inflow of the chemically reactive, first agent [335] relative to inflow of the chemically nonreactive, second agent [354,320] and said volumetric inflow ratio is in the range of about 1-to-10 (1:10) to about 4-to-10 (4:10).

28. The residue reducing method [300] of Claim 27 wherein said volumetric inflow ratio is in the range of about 2:10 to about 3:10.

29. The residue reducing method [300] of Claim 28 wherein said volumetric inflow ratio is about 1:4 (25%).

30. The residue reducing method [300] of Claim 29 wherein

said chemically reactive, first agent [335] includes chlorine and said chemically nonreactive, second agent [354,320] includes argon.

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